

increases the danger of the anæsthesia is also proven in the case reported by Dr. Dalton. The test was experimentally employed here six times; in five, hydrogen was used and in the sixth it was replaced by air. In three of the five it was a success, noting in one the absence of any perforation, while in the other two it escaped and burned in a jet.

The remaining two could not be insufflated, owing to a perfect occlusion of the intestinal lumen with faecal matter. Several attempts were made to overcome the obstruction with different tubes and rectal plugs, but without success, and it became evident that nothing short of its removal would suffice. The one in which there was an absence of a gastro-intestinal perforation, was corroborated by an abdominal section, and when the search was finished it became somewhat troublesome to reduce the distended intestines.

The danger of an explosion, as well as poisoning from arseniuretted hydrogen, have also been hinted, but these cannot be fairly urged against it, since, of the first sufficient evidence is at hand to allay any fears in this direction and if the reagents are chemically pure, as recommended, the second is impossible. But further on more can be seen upon this subject.

Reflection bespeaks a serious condition even in the most favorable cases, and, naturally, the prognosis increases in gravity with the extent of the injury. Although there is recorded a successful case¹ in which laparotomy was not undertaken until the fifth day, the importance of an early operation cannot be too strongly urged.

Procrastination in these injuries is usually repaid with a liberal share of harmful consequences.

Death very soon after the injury is generally either from hæmorrhage or shock and not infrequently the latter is very much dependent upon the hæmorrhage. When death occurs later it may be due to peritonitis or more generally from some of the septic processes already named.

TREATMENT.

The treatment divides itself into three indications. First, to

¹Klin. Zeit. und Streifragen, bd. ii., heft. 10., s. 355.

determine the penetration of the ball, together with the presence or absence of any intra-abdominal injury. Second, to correct the intra-abdominal injury, and third, the treatment of the complication secondary to the injury. For the fulfillment of the first indication we have at hand two procedures, Senn's rectal insufflation of hydrogen and laparotomy. As for the choice between these two, laparotomy, boldly but carefully performed, seems decidedly the most preferable, for when the *ensemble* of objections urged against the test are considered the advantages of its use are not sufficient to outweigh the harm that may result. According to Trélat,¹ intra-abdominal injury follows in 97 out of 100 perforations, and drawing a more liberal margin of 95 in 100 would leave but 5 out of 100 in which the operation was purely exploratory.

Although the dangers of a simple laparotomy, even in a subject otherwise healthy, are not to be denied, yet where the precautions against infection are scrupulously observed the mortality will be exceedingly low and the operation certainly seems a justifiable step in the face of what was reasonably supposed to be a very serious condition. Nor does the medico-legal aspect appear to suffer any improvement by the general adoption of the test since in consideration of the objections already offered the test in the event of an unfavorable termination where intra-abdominal injury is present, may possibly give rise to the same debatable questions that attend an unfavorable exploratory operation without intra-abdominal injury.

In every case that laparotomy is undertaken it should be with the preparation and expectation of finding intra-abdominal injury. By most surgeons the laparotomy in the linea alba is given the preference over that of one performed in the course of the ball since occasionally the course of the latter is such that its following is inadmissible and often it necessitates the making of very large and undesirable incisions, while a laparotomy in the linea alba not only furnishes the easiest access to all the organs but also its making is attended with less hæmorrhage, and is generally a more desirable wound for closure and subsequent treatment.

¹The Medical and Surgical Reporter, May 12, 1888.

However where it is highly probable that the ball has become arrested in the abdominal parietes, or where infection of its track is suspected either from the use of the probe or fragments of clothing carried in with the ball, incision and drainage should always be employed, not only for diagnostic purposes but also for the proper treatment of the bullet wound under such circumstances. But only where the ball is very small and given at a long range with a transit through several layers of clothing or a very thick abdominal wall can its arrest without penetration be hoped.

Ordinarily probing of the bullet wound should be carefully avoided, for the cases of non-penetration when the abdominal wall is fairly wounded are extremely few, and the experiences of Esmarch and others have conclusively proven this a source of infection in all gun-shot wounds. In all of the experiments the abstention of interference with the bullet wound was followed by an absence of suppuration from this source.

Following the opening of the abdominal cavity comes the search for and repair of the intra-abdominal injury. The search for the wounds of the gastro-intestinal tract may either be made through a large incision with "eventration" or through a small one hooking up a coil of the intestine and carefully tracing the whole tract from end to end. The apparent advantages of the former are, that it affords an easier access and better command over the whole of the intestines and their attachment. Both have been employed in the experiments and each seems to have its advantage. Where there is profuse hæmorrhage or extensive damage of the intestines with danger of extravasation "eventration" would be the shortest way of locating the hæmorrhage, and the best control over extravasation, but where upon opening the cavity it is apparent that little or no hæmorrhage has occurred a loop of intestine can be carefully hooked up through a small opening, and the whole intestinal tract examined without exposing more than about six inches at one time. In those cases where from the wound of entrance and exit the other organs can be safely excluded from the path of the ball such an examination will suffice; otherwise if necessary the incision can be enlarged till a

satisfactory ocular or digital examination will prove the absence of injury to any or all of the other viscera.

My co-worker, Dr. Vance, ingeniously unbent and covered the ordinary safety pin with rubber tubing or fine catheter and by piercing the mesentery on each side of the wound where it is devoid of vessels has succeeded in sealing the wound against extravasation during the examination or closure of any intestinal injury. The principle has been found to be advan-

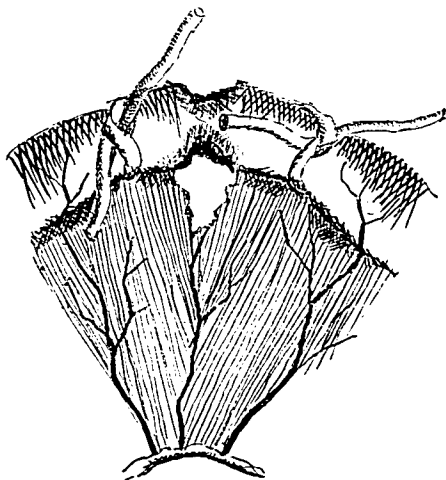


FIG. 3.—SHOWING THE APPLICATION OF THE RUBBER TUBING FOR CONTROLLING FECAL EXTRAVASATION.

tageous, but owing to the projecting points of the pins which frequently caught and damaged the omental folds and mesentery the latter was found somewhat impracticable and in lieu of which, the writer substituted ordinary small rubber tubing as shown in Fig. 3, which can not only be used for the purpose already named, but from its simplicity and cheapness will afford an admirable substitute for the many clamps already suggested for the control of extravasation during re-

section and other intestinal operations. In its application a single knot will suffice and too much traction should be avoided.

The injuries of the intestinal tract may be variable in character. For clinical and prognostic purposes they can be arranged as contusions, penetrating and non-penetrating wounds. The contusions are often quite large and attended with corresponding hæmatomas. The penetrating wounds for the purpose of treatment admit of the division into those isolated from and those involving the mesenteric border. By the latter is meant such as encroach upon that portion of the intestine which is devoid of serous covering, and contained in the triangular interspace formed by the union of the two folds of mesentery

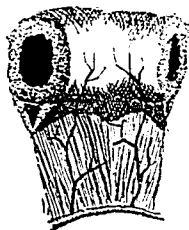


FIG. 4.—SHOWING THE ABSENCE OF THE SEROUS COVERING AT THE MESENTERIC BORDER OF THE INTESTINE.

see Fig. 4. Because of this absence of the serosa, which precludes the possibility of obtaining "plastic adhesion" in a few hours, which is so indispensable in intestinal suturing, as well as the interference with the blood supply of the intestine which attends wounds in this location, they are justly to be regarded as the most serious of intestinal wounds. Space will not permit a review of the various mechanical measures already recommended, for the care of intestinal injuries and the remarks in this direction will be confined to such as by the present opinions are deemed most efficient and advantageous. Hæmatomas were frequently met with at the intestinal border

of the mesentery and sometimes about the intestine proper. When unattended with a wound they were left untouched without any harm resulting, but in the reverse for additional security, they are best treated as a perforating wound.

For the closure of intestinal wounds various stitches have been recommended, prominent among which are the Lembert, Gely, Gussenbauer, Czerny and the continued suture. Of these nearly all have been experimentally employed, and as for safety, simplicity and efficiency none recommends itself as strongly as the Lembert stitch. The latter when applied, should not be too far apart (3 or 4 lines), and to insure security should not include too narrow a strip of the serous surfaces. Unless the wound be linear in character the stitches are best introduced parallel with the long axis of the intestine, since by such its lumen suffers least from coarctation.

In tying the sutures only sufficient traction should be employed to bring the opposite sides in contact. This apposition is soon followed by a slight œdema and the commencement of exudation which adds to the safety of the closure. The secure closure of the wound, particularly at the angles, is sometimes misleading. In at least two experiments death was due to an infection traceable apparently to this source. Unless the edges of the wound are so ragged and everted as to interfere with their closure trimming is unnecessary and superfluous. It has been noted in several of the experiments that were followed by early deaths that these edges level themselves into rounded ridges on each side of the wound during the first 24 hours after their closure, Fig. 5 (a). According to Lembert the stitches ulcerate their way into the intestinal cavity by the seventh or eighth day, and are discharged. It was repeatedly noticed that in 36 or 48 hours sufficient exudate was thrown out to cover the entire suture externally. In gunshot perforations the mucosa was frequently observed in those cases where death followed during the first 24 hours to be denuded of its epithelial layer for four or five lines beyond the opening, with a slightly congested zone for its boundary. Where the stitches were introduced entirely through the muscularis "or deeper," they were generally visible internally